

Syllabus: MP520 Computer Systems in Medicine

Radiological Technologies University

COURSE INFORMATION:

This course serves as a basic introduction to Software, Hardware, and Network Computer Systems used in Medical Applications. While the focus will be on Diagnostic Radiology, Nuclear Medicine, Radiation Oncology, and the PACS (Picture Archiving and Communication System); we will also be looking at emerging technologies such as 3D Scanning and 3D Printing; and other medical technologies commonly in use. The course will be hybrid in that there will be Digital and Classroom lecture components which will use both Synchronous and Asynchronous technologies and methods.

The fields of Computer, Information, Biological, and Medical Technology are changing rapidly. In fact, it will be shown that this change is accelerating and that the rate of acceleration of the change is increasing. New technologies have appeared recently which very likely will radically change the way Humans work and think. With the cost of medical care spiraling out of control and the demographic changes taking place, there will be increasing demands for change to occur and costs to be lowered. The way people live has and will be rapidly and radically transformed; understanding the systems which underlie our Biology, Human Organization, Computer Technology, and Medical Technology; will be critical if we are to optimally manage and address the problems ahead of us in the future.

The course will begin with a brief but comprehensive introduction to Systems Theory and how it relates to the subject matter under consideration. For too long a time and to a great extent even today; education and pedagogy have focused upon a reductionist perspective in both the Biological and Medical Fields. This course will attempt to 'bridge' the fields of Computer, Information, Biological, and Medical Sciences; by showing how General Systems Concepts underlie each of them and how no comprehensive understanding can be had in an attempt to manage or control them without recognizing that which lies at the foundation of each of their bodies of knowledge. The Critical Technologies which are being utilized in the fields of Computer, Information, Biological, and Medical Systems will be discussed from a Systems perspective and a practical hands-on approach. The focus

for this course will be upon the development of the requisite skills necessary to work with these technologies and then in using those skills to enhance the understanding of the Systems which underlie the technologies. The extension and application of these skills to the dynamic and rapidly changing fields of Medicine, Biology and Information Systems will be the ultimate goal of the course; since the future environment which most of us will be operating within will require the constant refinement and enhancement of such skills.

While the course will cover what appears to be a tremendous amount of material which possesses a high degree of complexity; it will be evident that the veil of complexity can be lifted when the proper tools and methodologies are used to describe, study, and explain the systems under investigation. It should be understood that the study and understanding of Systems requires a constant refinement of the tools and skills which are currently being used in the various fields.

Instructor: Gerard Arthus – BA, BS, MA, and MS

Contact Information: I can be reached at any time and usually am up until 0300-0400 hrs.

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REQUIRED COURSE MATERIALS:

Reading and study materials will be provided as needed; and will be in various digital formats including text, PowerPoint Presentations, images, video files, and audio files. All Course materials including the Syllabus will be hosted at the following Course Portal: <http://openeducation.org/moodle/> (You can log in as guest to look around, once you are given a user-name you will be able to log into the course or any other course to do the work. Also anyone is free to use any of the courses in the portal if they desire. All tests, quizzes and assignments will be completed through this portal, but grades will be posted in the RTU Jacobi Campus.

The Course Portal within which the class is conducted will have a fully integrated class environment based upon a WizIQ module running in Moodle LCMS (Learning Content Management System). It provides a virtual classroom environment with embedded Video, Audio, Presentation capability, and video conferencing. Lectures will be recorded and available for download at any time.

REQUIRED EQUIPMENT AND SOFTWARE:

The student will need a computer which has access to **LibreOffice**. There is a free download available from: <http://www.libreoffice.org/> This application is a fork of Open Office and has a much cleaner code-base, runs faster, and uses less resources than Open Office or Microsoft Office. Be sure to install at least **Writer, Calc, Base, and Math**. Most of the assignments with **Calc** could also be completed in Microsoft Excel. **GIMP** will be used to look at DICOM image transport format files and the PACS image storage and transfer architecture; used for CT, MRI, 3D Scanners, and 3D Printers. We will also be working with **G-Code type** software which is used for 'Rapid Prototyping' when working with CAD (Computer Aided Design) and STL (Stereo-Lithography or Standard Tessellation Language) files. G-Code is a computer numerical control (CNC) programming language and has many variants. All of the required software and applications will be provided and will be available at little to no cost. They will be installed as part of the coursework and all of them should work on most Windows-based computers.

SUPPLEMENTAL WORKSHOPS:

Students are expected to enter this course with certain skills which are necessary to understand Basic Systems Concepts. Supplemental Workshops will be scheduled and recorded, covering selected subjects related to the Course Objectives. Student attendance is recommended but not required. The idea behind these workshops is to enhance the understanding of the Critical Concepts which are necessary for a fundamental understanding of the various areas covered in the course. These workshops will be integrated into the course while remaining as free-standing lectures, targeted towards specific aspects of the course. Some of the planned workshops will include:

- An Extended Workshop covering Basic Computer Hardware Operations
- An Extended Workshop covering Computer System Optimization
- An Extended Workshop covering Basic Computer Operating Systems and Software Applications
- An Extended Workshop covering Basic Mathematical Concepts necessary to fully understand the course materials
- An Extended Workshop covering Basic Programming concepts

COURSE DESCRIPTION:

In this course, students are presented with material that will ensure a standard level of computer capability. The students should be acquainted with the basics of the operation of modern computers and operating systems. We will review useful features of spreadsheet and database software (LibreOffice Calc and LibreOffice Base, analogous to Microsoft Excel and Microsoft Access) as well as the LibreOffice Math equation formatting package. The student will be introduced to computer programming through JAVA and G-Code-based languages and applications such as: 3D Share, 3D Doctor, AnalyzeDirect, OpenScam, and RepRap Host Software.

The use of Computer and Information Technologies, Equipment, and Hardware within the Biological and Medical Sciences will be discussed from a Systems Perspective. Understanding how these tools function and how the various systems interact and integrate with each other will be of prime concern.

There will be an overview of the basics of computer networking and interfacing, the HL-7 hospital information interface standard, the DICOM image transport format and the PACS image storage and transfer architecture.

This course is worth 2 credit hours. Students can expect 2 hours of lecture and 4 hours of assignments per week. Lectures consist of:

- 1 to 2 hour video lecture per week
- 16 hours of lecture during Boot Camp
- 1 hour teleconference call or Skype session weekly

Note: Lectures at RTU can be delivered in the following formats: video streamed, weekly teleconference, Skype sessions, or in person lectures. The format we will be using for this course will be a WIZIQ Module running in a Moodle LCMS (Learning Content Management System). Weekly teleconferences or meetings will be mandatory for this class.

Federal Definition of Credit Hour: Except as provided in 34 CFR 668.8(k) and (l), a credit hour is an amount of work represented in intended learning outcomes and verified by evidence of student achievement that is an

institutionally established equivalency that reasonably approximates not less than--

(1) One hour of classroom or direct faculty instruction and a minimum of two hours out of class student work each week for approximately eleven weeks for one semester or trimester hour of credit, or ten or twelve weeks for one quarter hour of credit, or the equivalent amount of work over a different time; or

(2) At least an equivalent amount of work as required in paragraph (1) of this definition for other academic activities as established by the institution including laboratory work, internships, practica, studio work, and other academic work leading to the award of credit hours.

COURSE OBJECTIVES:

The student will demonstrate competency in and a 'Basic' understanding of the following concepts and areas of study:

- Systems Theory
- The relationship between Data, Information, and Knowledge
- The relationship between Efficiency, Effectiveness, and Optimization
- Information Searching and Location, Retrieval, and Validation.
- Understanding the scope and utility of the PubMed Database
- The Visualization of Patterns in Data and Information; and of the Relationships within Systems
- Information Systems and their Application to General Systems Theory
- Language Systems and their Application to General Systems Theory
- Logic Systems and their Application to General Systems Theory
- Computer Systems and their Application to General Systems Theory
- Biological Systems and their Application to General Systems Theory
- Medical Systems and their Application to General Systems Theory
- Mathematical Systems and their Application to General Systems Theory
- Networks and Homeostatic Systems and their Application to General Systems Theory

- Black Boxes and their Application to General Systems Theory
- Reverse Engineering and its Application to General Systems Theory
- The uses of selected features of Calc (and similar packages) which are appropriate to practical medical physics problems; e.g. Solver and Conditional Formatting.
- Understand databases and the basics of their operations
- Know the basic functions of Base database software
- Explore the various Mathematics programs available as Numerical programming packages and 3D visualization and Rendering Applications
- Format mathematical equations using SAGE an Open-Source alternative to MatLab, Maple, Mathematica, and Magma. Sage is built out of nearly [100 open-source packages](#) and features a unified interface. Sage can be used to study elementary and advanced, pure, and applied mathematics.
- The utilization of Applications such as Blender and Gimp to manipulate images in two and three dimensions
- Understand selected concepts of the various types of programming languages
- Understand the difference between an interpreted and a compiled programming language
- Understand selected basic concepts of Scripting languages
- Identify the basic components of a computer network
- Know the fundamentals of computer communication
- Be able to identify the components of a PACS (Picture Archiving and Communication System) and state their functions
- Know what the DICOM (Digital Imaging and Communications in Medicine) image format is and how it relates to the PACS (Picture Archiving and Communication System) concept
- Know the basics of the HL-7 standard and how it contributes to communications between hospital systems
- Understand the concepts underlying Telediagnosis and Teleradiology
- Understand the concepts underlying HIS (Hospital Information Systems), EMR (Electronic Medical Records), PMS (Practice Management Software, and RIS (Radiology Information Systems
- Understand the concepts underlying USI (Ultra Sound Imaging), MRI (Magnetic Resonance Imaging), PET (Positron Emission Tomography), ES Imaging (Endoscopic Imaging), MG Imaging

(Mammogram), DR Imaging (Digital Radiography, and CR Imaging (Computed Radiography).

- Understand the concepts underlying CNC (Computer Numerical Control), CAD (Computer Aided Design), 3D Printing and 3D Scanning
- Risk Management and its importance when dealing with Computer, Information, and Medical Systems.
- Understand the concepts underlying Bio-informatics
- The impact of technological developments in the Biological, Medical, and Information Systems on our Political, Social, and Economic (Human) Systems.

Computer Systems in Medicine Course Content Outline:

This schedule and the substance of this syllabus are subject to change.

Students should check the course homepage at:

<http://www.openeducation.org/moodle/> regularly for schedule changes and other announcements. Messages will also be sent to your Email account and posted within a News Forum in the course itself either periodically or as needed. There will be a significant amount of material covered during this course; since the Final Project and Final Exam will be made available during Week 09, a lecture and meeting will be held during finals week and students will be asked to complete a short oral presentation based upon materials covered during the course. This oral presentation will be a component of the final project which will consist of a written report and an oral presentation. The final exam will be comprehensive and will consist of mostly multiple choice exam-type questions and short answer questions. There will be a weekly Discussion Forum which will consist of a short (150 words or less) communication which should be in a format which is 'Clear, Concise, and Understandable'. All Discussion Forums must be completed; you will be graded on their content as well as the English Grammar used in your writing. Any report submitted when working at a job will be judged on the grammatical use of the writing and its informational content. Your posting should be clear and understandable and does not require a deep technical presentation. A weekly interactive quiz will also be posted for each week in the Portal and there will be Homework Assignments and Classroom Assignments which will be posted to the Portal and Emailed to the instructor. There will also be a list of required and Supplemental Readings; and Required and Supplemental Videos, posted for each week in the Portal.

Since there will be a significant amount of material to be covered during this course the instructor will allow flexibility concerning the due-dates for the assignments. All assignments must be submitted by not-less-than 24 hours before Final grades must be submitted. If someone is dissatisfied with a grade they receive on an assignment, it can be reworked and resubmitted.

There will be a Course Objectives and Outline document for each week; it will have a more detailed outline of the course materials to be covered for each week. Throughout the course students should be constantly referring to the materials covered during Week 1. Understanding the usefulness and limitations of General Systems Theory and its application to Computer Systems and the Equipment and Technologies currently in use in Biological and Medical systems will be critical throughout this course. This approach will also be of significant use after one leaves the university.

All references to Assignments and Activities will be directed to the Course Portal located at: <http://www.openeducation.org/moodle/>

Weekly Course Outline:

Week 1: General Systems

- General Systems Theory
- The System as an inseparable component of the world we live in
- Visualizing Patterns in Systems
- Visualizing and Modeling Systems
- What is a Dynamic System
- Systems and the concept of the Black Box
- Identifying the Critical Parameters of a System
- The Black box and Reverse-Engineering of Systems
- Why the concept of 'Systems' is critical for the understanding of Computer Systems, Medicine and the Equipment and Technologies used therein

Assignments:

- Readings as designated in the Course Portal for this week
- Videos as designated in the Course Portal for this week
- Discussion Forum covering the topic as designated in the Course Portal for this week
- In-Class Assignment as designated in the Course Portal for this week
- Homework Assignment as designated in the Course Portal for this week

- Quiz as designated in the Course Portal for this week

Week 2: Information Systems

- Information Systems
- Language Systems
- Logic Systems and 'Fuzzy' Logic
- Information Theory
- Data, Information, and Knowledge
- Communication as a Critical function of all systems
- Visualizing Patterns in Data and Information
- Information Retrieval and Validation
- The misdirected 'Straw-man' concept of Information Validation based upon the authority of the person who is its source
- The Internet as an Information Resource
- Pub-Med as the prime resource for Medical Information
- Why Information Theory, Language, and Logic are Critical for the understanding of Computer Systems, Medicine and the Equipment and Technologies used therein

Assignments:

- Readings as designated in the Course Portal for this week
- Videos as designated in the Course Portal for this week
- Discussion Forum covering the topic as designated in the Course Portal for this week
- In-Class Assignment as designated in the Course Portal for this week
- Homework Assignment as designated in the Course Portal for this week
- Quiz as designated in the Course Portal for this week

Week 3: Mathematical Systems

- Mathematical Systems and their application to General Systems Theory
- The concept of Simplification, Abstraction, and Problem Solving
- Patterns of Information in Mathematical Systems
- The concept of the Functional
- Mathematical Modeling of Systems
- Why Mathematical Systems are critical for the understanding of Computer Systems, Medicine and the Equipment and Technologies used therein

Assignments:

- Readings as designated in the Course Portal for this week
- Videos as designated in the Course Portal for this week
- Discussion Forum covering the topic as designated in the Course Portal for this week
- In-Class Assignment as designated in the Course Portal for this week
- Homework Assignment as designated in the Course Portal for this week
- Quiz as designated in the Course Portal for this week

Week 4: Computer Systems

- Computer Systems and their application to General Systems Theory
- Operating Systems and their application to General Systems Theory
- Software and Application Systems and their application to General Systems Theory
- Database Systems and their application to Computer Systems
- Files, Folders, Data, and Information Storage with Computer Systems
- Why Computer Systems are critical for the understanding of Medical Systems and the Equipment and Technologies used therein

Assignments:

- Readings as designated in the Course Portal for this week
- Videos as designated in the Course Portal for this week
- Discussion Forum covering the topic as designated in the Course Portal for this week
- In-Class Assignment as designated in the Course Portal for this week
- Homework Assignment as designated in the Course Portal for this week
- Quiz as designated in the Course Portal for this week

Week 5: Networks and Homeostatic Systems

- The general concept of a Network
- Electrical Networks
- Computer networks
- Biological Networks
- Artificial Neural Networks
- Social Networks
- Telecommunications Networks
- Homeostatic Systems as the basis for Systems Stability
- Homeostasis and the Receptor/Effector Model

- Why Networks and Homeostatic Systems are critical for the understanding of Computer Systems, Medicine and the Equipment and Technologies used therein

Assignments:

- Readings as designated in the Course Portal for this week
- Videos as designated in the Course Portal for this week
- Discussion Forum covering the topic as designated in the Course Portal for this week
- In-Class Assignment as designated in the Course Portal for this week
- Homework Assignment as designated in the Course Portal for this week
- Quiz as designated in the Course Portal for this week

Week 6: Systems Biology

- Control Theory
- Cybernetics
- Computational Biology
- Bio-informatics
- Computers and Biological Systems
- Why the concepts used in Systems Biology are critical for the understanding of Computer Systems, Medicine and the Equipment and Technologies used therein

Assignments:

- Readings as designated in the Course Portal for this week
- Videos as designated in the Course Portal for this week
- Discussion Forum covering the topic as designated in the Course Portal for this week
- In-Class Assignment as designated in the Course Portal for this week
- Homework Assignment as designated in the Course Portal for this week
- Quiz as designated in the Course Portal for this week

Week 7: Medical and Biological Systems

- Biological and Medical Systems
- The Health Care System
- The role of Computer Systems in Medicine and Health Care

Assignments:

- Readings as designated in the Course Portal for this week
- Videos as designated in the Course Portal for this week
- Discussion Forum covering the topic as designated in the Course Portal for this week
- In-Class Assignment as designated in the Course Portal for this week
- Homework Assignment as designated in the Course Portal for this week
- Quiz as designated in the Course Portal for this week

Week 8: Medical Systems Data and Information Collection

- Electronic Medical Records Systems
- Decision Theory
- Diagnostic Procedure
- Medical Diagnostics (Diagnosis)
- Pattern Recognition and its use in Diagnostic Procedure
- Diagnostic Criteria
- Diagnostic Types
- The role of Computer Systems in Medical Systems Data and Information Collection

Assignments:

- Readings as designated in the Course Portal for this week
- Videos as designated in the Course Portal for this week
- Discussion Forum covering the topic as designated in the Course Portal for this week
- In-Class Assignment as designated in the Course Portal for this week
- Homework Assignment as designated in the Course Portal for this week
- Quiz as designated in the Course Portal for this week

Week 9: Medical Equipment and Computer Systems

- Medical Technology
- Medical Diagnostic Equipment
- Medical Monitors
- Medical Laboratory Equipment
- The Role of the Biomedical Equipment Technician (BMET)
- Robotic Surgery and Equipment
- The role of Computer Systems in the operation of Medical Equipment
- Final Project and Final Exam will be open beginning this week.

Assignments:

- Readings as designated in the Course Portal for this week
- Videos as designated in the Course Portal for this week
- Discussion Forum covering the topic as designated in the Course Portal for this week
- In-Class Assignment as designated in the Course Portal for this week
- Homework Assignment as designated in the Course Portal for this week
- Quiz as designated in the Course Portal for this week

Week 10: Computer Programming Concepts

- General Programming Concepts
- G-Code and Languages used for CNC, 3D Scanning and Printing, and Medical Equipment
- C, C++, Matlab, SAGE, and JAVA Languages and Medical Equipment
- Software Applications available for operating Medical Equipment, performing Medical Diagnostics, 3d Scanning and Printing, and Medical Imaging (Dicom and PACS).
- The role of Computer Systems in the operation of Medical Equipment

Assignments:

- Readings as designated in the Course Portal for this week
- Videos as designated in the Course Portal for this week
- Discussion Forum covering the topic as designated in the Course Portal for this week
- In-Class Assignment as designated in the Course Portal for this week
- Homework Assignment as designated in the Course Portal for this week
- Quiz as designated in the Course Portal for this week

Week 11: Finals Week

- There will be a short lecture this week which will attempt to tie everything together and talk about where we are heading with the new technologies which have just now entering the 'mainstream'.
- Students should complete their final exams by this week
- Final Projects are due and each student will give a 15 minute presentation on the assigned topic.